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ADD HIGH-RAP TO YOUR PRODUCTION

A primer on how high-RAP mixes are made and used



This roadway in Virginia was paved using a mix with high-RAP and ReLIXER rejuvenator. *Photo courtesy of Sripath Technologies*

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Editor's Note: For 2024, AsphaltPro Magazine allows experts in the industry to share how to expand your operations to the next phase of business. Are you ready to take the plunge and increase your recycling efforts? Let's turn to some professionals who have equipment, services, software and tenure to help you expand to mix design, production, hauling and more. This month's installment from Sripath Technologies takes a look at methods of increased recycle content with mini case studies of the company's additive products.

When an asphalt pavement reaches the end of its life, it is milled off the roadway and crushed to create reclaimed asphalt pavement (RAP). Over time, mountains of RAP can accumulate—depending on the depth milled, just one lane-mile of pavement can generate several hundred tons.

For decades, RAP was considered a burden—waste material to be used on shoulders or stored in ever-growing piles. It was not un-

til the 1970s that our industry began to realize its incredible potential for reuse and recycling. The National Asphalt Pavement Association (NAPA) reported in 2021, over 95% of RAP generated in the United States is re-incorporated into new pavement. And it's not hard to see why. The use of RAP presents a trifecta victory for business through cost-savings, sustainability and road performance.

Contractors champion recycling as it helps them save on raw materials like virgin asphalt binder, typically the greatest expense in mix production. Reuse also benefits the environment, as it keeps old pavement out of landfills and reduces demand for carbon-intensive virgin materials, thereby cutting greenhouse emissions. And many transportation agencies now recognize that high-RAP roadways made with proper ingredients and mix design can yield equivalent performance to virgin-material pavement. Given its growing popularity, understanding the fundamental steps involved in RAP recycling is important for anyone in the asphalt industry.

SOURCING AND PREPARING RAP

The first step is to source and prepare your RAP, which can come from anywhere there was once asphalt pavement, including waste material from production facilities. Many transportation authorities are indifferent to RAP sourcing, as long as final aggregate and mix characteristics meet their specifications. However, some agencies are more restrictive, allowing only RAP that can be traced back to a specific project.

RAP particle size varies significantly, ranging from fine to coarse particles. Variability must be addressed, as an improper ratio of small to large particles can lead to poor gradation. Too many large pieces will not pack together properly, leaving excessive space between particles. Too many small particles will make the mix overly dense and therefore susceptible to cracking. Thus, it is important to classify RAP into different size fractions, allowing contractors to produce high-performance mixes that incorporate RAP from many sources.

Table 1.

VDOT Organizes Demonstration Trial of 40% RAP Mix Dosed with ReLIXER								
Sample	PG 64-22 Martinsburg %	ReLIXER %	ODSR @ 64°C kPa	RV @ 135°C Pa-s	MSCR Jnr3.2 @ 64°C kPa ⁻¹	BBR stiffness @ -12°C kPa	BBR m-value @ -12°C	ΔT _c °C
Control	100.0	0.0	1.36	0.41	2.21	177	0.331	-1.2
High-RAP Mix	97.8	2.2	0.73	0.33	4.17	100	0.361	-1.1

Table 2.

ReLIXER® Approved by Illinois Tollway				
Property	PG 46-34 Mix*	PG 58-28 + ReLIXER	PG 58-28 + ReLIXER	Specification (Target)
Total Asphalt Content, %	-	2.0	3.6	
DCT -12°C, J/m ²	435	497	544	450
Hamburg, mm@20K	6.34	8.70	8.77	12.5 @ 10K
Voids, %	3.7	3.6	4.9	4.0
Total AC, %	6.0	6.1	5.8	6.1
Virgin AC added, %	4.3	4.0	3.7	-
AC Grade	PG 64-22	PG 64-22	PG 64-28	PG 64-22
ΔT _c , °C	-5.8	-5.4	-3.7	-6.0

* One Grade Softer

Tables courtesy of Sripath Technologies

The key stages of RAP preparation are:

- Screening: Mechanically screen RAP to separate large pieces and remove extraneous materials
- Crushing: Break apart large pieces with a crushing machine. Avoid pulverizing particles that are already small, as it will create dust.
- Fractionation: Separate and sort the crushed RAP into multiple size groups. Although this practice is not done in all asphalt recycling operations, it allows for a more flexible mix design and the use of higher RAP content.
- Homogenization: Once sorted into piles of different sizes, turn over each pile several times to make a more homogenous feed stock for plant operations.

SAMPLING AND MIX DESIGN

To design a high-performance mix, it's important to properly characterize the RAP aggregate and binder. Start by sampling the crushed and homogenized RAP stock, making sure to retrieve several representative samples. Extract aggregates from the RAP sample using an ignition oven or solvent. Determine the size analysis of these aggregates. It is important to have an optimal balance of fine and coarse particles. Next, extract and determine characteristics of the aged binder, as its properties will affect the final mix.

Crucial for the success of high-RAP mixes is a carefully engineered and balanced mix design. Fortunately, designing a high-RAP mix is similar in many ways to designing a traditional mix, aside from a few key steps. First, you must account for binder content in the RAP when determining how much virgin bitumen to add. Without factoring this into your calculations, the mix will likely be too rich in binder content. Second, most mixes with more than 25% RAP content, will require an asphalt rejuvenator or recycling agent. Many recycling agents are available, and choosing the right one will make a substantial impact on the pavement's performance and lifespan. It will also affect your manufacturing and paving efficiency.

An ideal rejuvenator should:

- Soften the aged RAP binder,
- Restore the functional properties of the aged binder,
- Deliver excellent roadway performance and durability,
- Help improve compactability of stiff RAP mixes.

Designing a high-RAP mix requires a careful balance between cracking and rutting resistance. Several methods exist to evaluate cracking, including the Disc-shaped Compact Tension (DCT) test, Semi-Circular Bend Test (SCB), IDEAL-CT, Texas Overlay, and I-FIT test. Some commonly used methods to eval-

uate rutting performance include: Hamburg Wheel Tracking (HWT) and Asphalt Pavement Analyzer (APA) rutting test. Contractors nationwide have used Balanced Mix Design protocols to reap the benefits of recycling while maintaining excellent road performance.

RAP IN ACTION

One recent case study comes from the Virginia Transportation Research Council (VTRC), which organized a high-RAP demonstration trial in Ashburn, Virginia. Around 6,000 kg of PG64-22 binder dosed with ReLIXER®, an asphalt rejuvenator manufactured and marketed by Sripath®, was mixed with 40% RAP and fresh aggregates to produce about 2,000 metric tons of high-RAP mix. This mix was used to pave a 40 mm wearing course on an approximately 8 lane-km stretch of roadway in Ashburn, Virginia. As shown in Table 1, binder extracted from the high-RAP mix showed characteristics comparable to binder from the low-RAP control.

Another success story comes from the Illinois State Toll Highway Authority, which manages a 475 km network of highways across Illinois, subject to high traffic and extreme weather conditions. Close to 5,000 tons of a 40% ABR mix was produced to lay down 8 lane-km of wear, base, and shoulder courses on US Interstates I-88 and I-294. ReLIXER® additions at 2.0% and 3.6% of total bitumen content were evaluated. For comparison, a "softer" bitumen mix was also evaluated. As shown in Table 2, the properly designed and rejuvenated high-RAP mixes surpassed all local specifications for low temperature cracking, rutting and air voids.

Recycled asphalt has made a long journey from being a waste material to becoming a cornerstone of our national sustainable infrastructure, demonstrating our industry's dedication to environmental sustainability. The journey has only just begun. With an increase in recycling and reuse of reclaimed asphalt, the industry is poised to take advantage of the trifecta that RAP offers; a positive impact on sustainability, improved roadway performance and durability, and the benefits of cost-savings. **AP**